

WE CLAIM:

1 1. A method for non-intrusively measuring carbon dioxide
2 (CO₂) in a high temperature gas flow containing water vapor
3 (H₂O), said method comprising:

4 providing a laser sensor;
5 operating said laser sensor at a selective wavelength
6 substantially near 2 μ m,

7 selecting the R(50) spectroscopic transition of the
8 $\nu_1+2\nu_2+\nu_3$ CO₂ absorption band in near-infrared;

9 utilizing said laser sensor to spectrally interrogate said
10 R(50) spectroscopic transition for sensitive measurements of
11 CO₂, wherein said R(50) spectroscopic transition is
12 substantially isolated from interfering absorption by high
13 temperature species including said water vapor (H₂O) present in
14 said high temperature gas flow.

1 2. The method of claim 1, wherein said high temperature is
2 characterized to be more than 400 K.

1 3. The method of claim 1, wherein said interfering high
2 temperature species further comprising CO, NH₃, N₂O, and NO.

1 4. The method of claim 1, wherein said gas flow is generated
2 by a combustor and said measurements of CO₂ are taken *in situ*
3 in said combustor.

1 5. The method of claim 1, wherein said measurements of CO₂
2 are taken in a process chamber or in a sampling line.

1 6. The method of claim 1, wherein said laser sensor comprises
2 a fiber-coupled distributed feedback diode laser.

1 7. The method of claim 1, wherein said laser sensor comprises
2 a non-fiber-coupled laser, a Fabry-Perot (FP) diode laser, a
3 distributed Bragg reflector (DBR) laser, a quantum cascade
4 laser, an edge-emitting diode laser, or a vertical cavity
5 surface-emitting laser (VCSEL).

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1 8. The method of claim 1, wherein said interrogation utilizes
2 a spectrally resolved technique comprising scanned- and fixed-
3 wavelength absorption, balanced ratiometric detection,
4 frequency-modulation (FM) spectroscopy, photothermal
5 deflection, and photoacoustic spectroscopy.

1 9. A system having a plurality of multiplexed laser sensors
2 operating at a plurality of selective wavelengths for non-
3 intrusively and simultaneously measuring combustion parameters
4 including carbon dioxide (CO₂) along a single optical path in a
5 high temperature gas flow containing water vapor (H₂O), wherein
6 the improvement comprising:

7 one of said laser sensors operating at a wavelength
8 substantially near 2 μm spectrally interrogates a selective
9 R(50) spectroscopic transition of the $\nu_1+2\nu_2+\nu_3$ CO₂ absorption
10 band in near-infrared for accurate measurements of CO₂, wherein

11 said R(50) spectroscopic transition is substantially
12 isolated from interfering absorption by high temperature
13 species present in said high temperature gas flow.

1 10. The system of claim 9 further comprising:

2 a multimode optical fiber into which output beams from
3 said multiplexed lasers are combined;

4 a collimating lens for directing said combined output
5 beams through said high temperature gas flow; and

6 a diffraction grating for demultiplexing said combined
7 output beams so that transmitted intensity from each of said
8 plurality of laser sensors as well as said combustion
9 parameters can be simultaneously independently monitored along
10 said single optical path by a plurality of detectors.

1 11. The system of claim 10, wherein said combustion parameters
2 further comprise H₂O and temperature.

1 12. The system of claim 10, wherein said plurality of
2 detectors comprise extended wavelength response detectors.

1 13. The system of claim 9, wherein said high temperature is
2 characterized to be more than 400 K.

1 14. The system of claim 9, wherein said interfering high
2 temperature species comprises said water vapor.

1 15. The system of claim 14, wherein said interfering high
2 temperature species further comprises CO, NH₃, N₂O, and NO.

1 16. The system of claim 9, wherein said gas flow is generated
2 by a combustor and said measurements of CO₂ are taken *in situ*
3 in said combustor.

1 17. The system of claim 9, wherein said measurements of CO₂
2 are taken in a process chamber or in a sampling line.

1 18. The system of claim 9, wherein said plurality of laser
2 sensors are characterized as fiber-coupled distributed feedback
3 diode lasers.

1 19. The system of claim 9, wherein said plurality of laser
2 sensors are characterized as non-fiber-coupled lasers, Fabry-
3 Perot (FP) diode lasers, distributed Bragg reflector (DBR)
4 lasers, quantum cascade lasers, edge-emitting diode lasers, or
5 vertical cavity surface-emitting lasers (VCSEL).

1 20. The system of claim 9, wherein said interrogation utilizes
2 a spectrally resolved technique comprising scanned- and fixed-
3 wavelength absorption, balanced ratiometric detection,
4 frequency-modulation (FM) spectroscopy, photothermal
5 deflection, and photoacoustic spectroscopy.